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News Briefs

General Developments

Inquiries about News Briefs, where no contact person is identified, should be referred to the Managing Editor, Journal of Research, National Institute of Standards and Technology, Building 101, Room E215, Gaithersburg, MD 20899-2500; telephone: (301) 975-3577.

NIST DEVELOPS SMART SPACE TEST BED

NIST is developing a test bed, data transport system, and metrics to support the development by industry of Smart Work Spaces. These will blend sensor-based perceptual interfaces, pervasive computers, flexible networking, and information retrieval tools to support the knowledge workers of tomorrow. They will use numerous, easily accessible computing devices connected to each other through both wired and wireless network infrastructure. This trend is creating new opportunities and challenges for IT companies to place computers and sensors in virtually every device, appliance, and piece of equipment in buildings, homes, workplaces, factories, and even clothing. Successful deployment requires new techniques in measurement, compatibility testing, frequency management, human computer interactions, and biometric security.

As part of this program, NIST developed Smart Flow System software to integrate and encourage interoperability of the numerous computing, imaging, speech, and other devices that may be incorporated into a Smart Space environment. The Smart Flow System is actually a middleware data transport and distributed processing system and is now being deployed, along with a unique 59-element microphone array, in several R&D laboratories.

Products developed in the Smart Space Test Bed are also being used in the Smart Meeting Room project and will be used in conjunction with a project in wireless networking performance and compatibility testing.

The program has also developed a novel signal-to-noise measurement algorithm based on Gaussian mixture estimation procedures. The algorithm allows measurement of the root mean square (RMS) power for the mixture of background noise, unvoiced fricative speech, and voiced speech encountered speech recognition experiments. This metric allows precise measurement of performance of noise reduction algorithms such as adaptive filters and beam formers used in speech signal acquisition.

Starting in 1998, NIST has conducted a series of annual industry conferences on Smart Spaces and pervasive computing. Some of these have been developed in cooperation with the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA). The 2001 Pervasive Computing Conference was held at NIST in May 2001. Details about the conference may be found at www.nist.gov/pc2001. More details about the NIST Smart Space Laboratory can be found at www.nist.gov/smartspace. CONTACT: Vince Stanford, (301) 975-5399; vincent.stanford@nist.gov.

NEW FINGERPRINT STANDARD APPROVED

NIST revised the standard and managed the ANSI approval procedures for the Data Format for the Interchange of Fingerprint, Facial, & Scar Mark & Tattoo (SMT) Information, ANSI/NIST-ITL 1-2000. The new version consolidates two previous standards published in 1993 and 1997. Two hundred federal, state, local, and international law enforcement agencies, criminal justice administrations, vendors, and other organizations participated in the development of the standard. The document is available in hardcopy as NIST Special Publication 500-245 and may be downloaded from the Web at www.itl.nist.gov/iad/894.03/fing/fing.html.

The standard defines the content, format, and units of measurement for the exchange of fingerprint, palmprint, facial, and SMT information that may be used in the identification of a subject. Exchanged information consists of several items, including record data, digitized characteristic information, and compressed or uncompressed fingerprint, palmprint, facial, and SMT images.

The standard forms the basis for interoperability between federal, state, local, and international users of Automated Fingerprint Identification Systems (AFIS) for the interchange of fingerprint search transactions. All agencies involved in the electronic transmission of fingerprint, palmprint, facial, and SMT images and related data must adhere to the format described by the standard. Dissimilar vendor equipment belonging to agencies submitting fingerprint images to the FBI must also adhere to the standard. In addition to being able to successfully submit fingerprint search transactions to the FBI, agencies that adhere to the standard can also effectively exchange fingerprint search transactions among themselves even though their systems are manufactured by different vendors. The FBI has been a supporter during the development of this standard, and has required that its AFIS system vendors comply with the provisions of the standard.

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NIST'S BIOMETRIC DATA FORMAT ENDORSED BY INDUSTRY

In February 2001, the International Biometric Industry Association (IBIA) launched the Biometric Standards Registry for Common Biometric Exchange File Format (CBEFF) Unique Identifiers to streamline the development of biometric solutions. CBEFF is the biometric data format spearheaded and developed by NIST in cooperation with industry and users. CBEFF describes a set of data elements necessary to support biometric technologies in a common way. It facilitates biometric data interchange between different system components or between systems, promotes interoperability of biometric-based application programs and systems, and facilitates the integration of biometric technologies into networks that support important mass commercial or government applications.

CBEFF is described in detail in NISTIR 6529, *Common Biometric Exchange File Format* (CBEFF). The development of CBEFF was performed in close coordination with industry consortiums, such as the BioAPI Consortium, and standards technical committees, such as ANSI/ASC X9F4 Working Group. The IBIA registry (www.ibia.org/formats) will greatly facilitate the use of all biometric technologies by those who develop, operate, and administer biometric solutions. CBEFF values in the IBIA Registry uniquely identify the format of a CBEFF-compliant biometric data structure. Detailed information on CBEFF and these identifiers can be found at www.nist.gov/cbeff.

The executive director of IBIA said, "The CBEFF initiative is a milestone for the biometric industry. Two years ago there was no easy way to accommodate multiple biometrics in complex networks. Now, with CBEFF and BioAPI, developers have all the tools needed to ensure interoperability in any environment. At the top of this list will be e-commerce applications that can rely on biometrics to secure both ends of a financial transaction." The chairman of IBIA said, "IBIA is pleased to be the registering entity for the Common Biometric Exchange File Format. The registry is vital to the future of biometrics because it will greatly facilitate the integration of biometric technologies into networks that have important mass commercial applications."

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NIST'S CRYPTOGRAPHIC MODULE VALIDATION PROGRAM ADDS FIRST PDA DEVICE

The Cryptographic Module Validation Program (CMVP) achieved another milestone by validating the first Personal Digital Assistance (PDA) device (Certificate #137). This cryptographic kernel firmware securely compresses and encrypts messages with Triple DES (Data Encryption Standards). Following this procedure, the ciphertext is transmitted over the Internet to the user's mail server. Upon receiving the message, the mail server decrypts and decompresses the ciphertext back to the original plaintext. The crypto firmware is messaging-system independent.

The FIPS 140-1 *Validated Modules List* has become a "Who's Who" of cryptographic and information technology vendors and developers from the U.S., Canada, and abroad. The list contains a complete range of security levels and a broad spectrum of product types now including PDAs in addition to secure radios, Internet browsers, VPN devices, PC Postage equipment, cryptographic accelerators, secure tokens, and others. The recent validations impact federal agencies by further increasing the number of tested and validated cryptographic products available for use in securing sensitive information.

The CMVP is a joint effort between NIST and the Canadian Security Establishment, who serve as the validation authorities for the program. The Web site is http://csrc.nist.gov/cryptval.

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NIST DEVELOPS METAL DETECTOR EMULATOR TO STUDY ADVERSE EFFECTS ON MEDICAL DEVICES

With the widespread use of metal detectors for security purposes in courthouses, penal institutions, and airports, a risk may exist for users of personal medical electronic devices (PMEDs) because of electromagnetic interference (EMI) from the magnetic fields generated by the metal detectors. An analysis of more than 80 medical device reports between 1987 and 2000 by the Food and Drug Administration's (FDA's) Center for Devices and Radiological Health reveals likely adverse interactions between the fields produced by metal detectors and PMEDs, such as cardiac pacemakers, implantable cardiac defibrillators, and drug infusion pumps.

An emulator that simulates the linearly-polarized magnetic fields of walk-through metal detectors was developed by NIST researchers for the FDA to conduct EMI tests of PMEDs. The emulator consists of a current source and specially designed coil that can simulate magnetic fields with adequate uniformity and with the rapid time varying characteristics found in some walk-through metal detectors, as well as numerous hand-held metal detectors. The electronic components are "off-the-shelf" devices and the specially designed coil system is readily fabricated. A coil fabricated by NIST was recently delivered to the FDA. Because the maximum voltage induced in PMEDs depends upon the time rate of change of the magnetic field, and because higher induced voltages are more likely to have adverse effects on PMEDs, it is important to accurately simulate the magnetic field amplitude and rapid temporal transitions. The emulator was designed to be flexible enough to simulate magnetic field waveforms of metal detectors now being examined by the FDA.

A manuscript describing the emulator system was recently submitted to the IEEE Transactions on Electromagnetic Compatibility for consideration as a publication. Because the emulator can be readily fabricated, manufacturers of PMEDs have the option of building their own emulators for conducting EMI tests of their products.

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NIST-SUPPORTED STANDARD ADOPTED BY RosettaNet E-COMMERCE CONSORTIUM

NIST has been involved in the development of standards for the exchange of electronic component information since co-sponsoring the first U.S. workshop on the subject in1991. NIST has worked with the Silicon Integration Initiative (Si2) consortium to develop standards in this area and the latest work on "QuickData" has recently migrated to RosettaNet. RosettaNet is a consortium of more than 350 of the world's leading information technology, electronic components and semiconductor manufacturing companies working to create and implement industry-wide, open e-business standards. For more information on RosettaNet, visit www.rosettanet.org.

NIST is helping the electronics industry take advantage of emerging Web-based electronic commerce technologies through this work with RosettaNet. To facilitate electronic commerce, NIST has developed a reference implementation for the RosettaNet Partner Interface Process (PIP) 2A9 *Query Electronic Component Technical Information* standard. This standard, formally the QuickData standard of Si2, allows for the exchange of component information between electronics industry customers and suppliers using the Extensible Markup Language (XML). Along with pricing information, the standard allows other information, such as timing diagrams, data sheets and simulation files, to be exchanged electronically. Engineers can "try before they buy" electronic components for use in their designs. NIST's reference implementation has been made freely available to the electronics industry, and is being used by several private companies as a basis for commercial products. Standards that help to quickly locate and evaluate the best components at the minimum cost are key to enabling companies to get products to market more rapidly. This standard is also being considered for use in the area of "virtual" electronic components (software representations of components for System-on-a-Chip designs) that could be bought and sold directly over the Internet.

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NEW MICROSCOPY CAPABILITY AT NIST

NIST has a new field-emission scanning electron microscope (FE-SEM) capable of high spatial resolution microstructural characterization of a wide variety of metal, ceramic, and polymer structures. This microscope has accelerating voltages from 500 V to 30 kV with spatial resolutions of 1.5 nm at 15 kV and 2.5 nm at 1 kV. The ability to maintain high resolution even at lower voltage allows the investigation of uncoated, non-conducting specimens, such as ceramics and polymers. The microscope is equipped with an energy dispersive x-ray spectrometer (EDS), back-scattered electron (BSE) detector, and faraday (picoampere) cups. The microscope has an improved objective lens electron detector system, which can be continuously adjusted to

allow for imaging with secondary or backscattered electrons. This improved design allows BSE imaging at low voltages (less than 5 kV) where conventional BSE de tectors are unsuitable. The new FE-SEM is expected to benefit a wide range of NIST research programs through high resolution materials characterization. The microscope is currently being used to evaluate the structures and compositions of thin- film multilayers, highly deformed metals, copper on-chip metallization, ceramic fracture surfaces, nanostructured powders, polymers with nano-scale porosity, and lithography masks.
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NEW HIGH T_c BORON SUPERCONDUCTOR

The surprise discovery very recently of superconductivity at 40 K in the binary MgB_2 system has triggered enormous interest in the structural, electronic, and superconducting properties of simple systems in general and this class of compounds in particular. From the experimental viewpoint, it is important to determine whether MgB_2 is an isolated, special exception, or if it is representative of a broad class of new superconducting materials. The emerging picture of this system is quite interesting. The crystal structure is layered, similar to intercalated graphite, and the band structure shows that it is a good metal due to the boron orbitals at the Fermi surface, while the Mg does not contribute appreciably to the conductivity. The hole-type conduction band is reminiscent of the high T_c cuprates, but, in contrast to the cuprates, the normal-state conductivity is three-dimensional in nature instead of being highly anisotropic, thus eliminating the "weak-link" problem that has plagued widespread commercialization of the cuprates. The conduction electron density and normal-state conductivity are also one to two orders-of-magnitude higher than either the Nb-based alloys or Bi-based cuprates used in present day wires, contradicting the conventional wisdom that good superconductors are poor conductors because of the strong electron-phonon interaction and at the same time providing encouragement that higher T_c materials will be found in this class.

From a fundamental point of view, the central question is whether the high T_c in this new system can be understood within the framework of a conventional electron-phonon mechanism, or a more exotic mechanism is responsible for the superconducting pairing. To answer this question, scientists from the Nist Center for Neutron Research, Princeton University, the University of Maryland, and the University of Pennsylvania have carried out temperature-dependent neutron measurements of the crystal structure and phonon density of states, and have compared these results with detailed first-principles calculations of the lattice dynamics and electronic band structure for MgB_2. Excellent agreement is found between theory and experiment, demonstrating that the calculations are able to capture the essential physics of this class of materials. The numerical results demonstrate that the in-plane boron phonons are strongly coupled to the conduction electrons, providing the large electron-phonon interaction in this system. This coupling gives rise not only to strong anharmonicity for these phonon modes, but to a large non-linear electron-phonon coupling that explains the high T_c in MgB_2.

The many interesting properties described above, combined with the low cost, lightweight, and easy fabrication of wires and thin films, makes this new material quite attractive for many applications. Additional information can be obtained at http://webster.ncnr.nist.gov/staff/taner/mgb2/.
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PARALLEL PROCESSING ENABLES RAPID COMPUTATION OF X-RAY ABSORPTION

A popular computer code for x-ray absorption spectroscopy (XAS) now runs 20-30 times faster, thanks to NIST. XAS is widely used to study the atomic-scale structure of materials and is currently employed by hundreds of research groups in a variety of fields, including ceramics, superconductors, semiconductors, catalysis, metallurgy, geophysics, and structural biology. Analysis of XAS relies heavily on *ab initio* computer calculations to model x-ray absorption in new materials. These calculations are computationally intensive, taking days or weeks to complete in many cases. As XAS becomes more widely used in the study of new materials, particularly in combinatorial materials processing, it is crucial to speed up these calculations.

One of the most commonly used codes for such analyses is FEFF. Developed at the University of Washington, FEFF is an automated program for *ab initio* multiple scattering calculations of X-ray Absorption Fine Structure (XAFS) and X-ray Absorption Near-Edge Structure (XANES) spectra for clusters of atoms. The code yields scattering amplitudes and phases used in many modern XAFS analysis codes. FEFF has a user base of over 400 research groups, including a number of industrial users.

To achieve faster speeds in FEFF, NIST researchers developed a parallel version. In modifying the code to run on the NIST parallel processing clusters using a message-passing approach, they gained a factor of

20-30 improvement in speed over the single processor code. Combining parallelization with improved matrix algorithms may allow the software to run 100 times or more faster than current single processor codes. The latter work is in process.

The parallel version of the XAS code is portable and is now also operating on parallel processing clusters at the University of Washington and at DoE's National Energy Research Scientific Computing Center (NERSC). A speedup of 30 makes it possible for researchers to do calculations they only dreamed about before. One NERSC researcher has reported doing a calculation in 18 minutes using FeffMPI on the NERSC IBM SP2 cluster that would have taken 10 hours before. In 10 hours, this researcher can now do a run that would have taken months before and hence would not have been even attempted.

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NIST SCIENTISTS ENSURE THE ACCURACY OF MEASUREMENTS MADE BY THE TRIANA SATELLITE

Physicists from NIST are working with scientists from the Scripps Institution of Oceanography at the University of California, San Diego, and a private company to ensure the reliability of measurements made by the Scripps Earth Polychromatic Imaging Camera (Scripps-EPIC) instrument. This unique spectroradiometer is one of three instruments aboard the Triana satellite scheduled to be launched aboard the space shuttle early in 2002. The Triana EPIC mission is designed to study the Earth, for the first time, from a vantage point of a million miles away and promises to offer new insights into how the planet's climate works as an integrated system.

Once it reaches its destination, Scripps-EPIC will begin to transmit a full-color image of the entire sunlit side of the Earth, with 8 km spatial resolution, every 15 minutes. These images will then be continuously distributed over the Internet. To perform these measurements, Scripps-EPIC uses a 4 million element charge coupled detector array attached to a 30 cm Cassegrain telescope with 10 wavelength channels in the ultraviolet, visible, and near-infrared spectral regions. The scientists performed the instrument's radiometric calibration, which is vital to obtaining useful scientific data since it determines the response of the instrument to the light it receives from Earth. The guiding principle for the calibration was to perform separate, controlled experiments for each parameter affecting the conversion from light to signal; these parameters are dark signal, linearity, exposure time, and spectral radiance responsivity.

Except for a few planetary fly-bys, such as Galileo, NASA has not deployed a spacecraft to provide the public with a full disk image of the Earth since Apollo.

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NEW PUBLICATIONS ON THE FUNDAMENTAL CONSTANTS

Two new publications that give selected subsets of the CODATA 1998 recommended values of the most recent fundamental physical constants are now available. They are NIST Special Publication (SP) 959, a wallet card; and NIST SP 961, a wall chart in two sizes: 8 1/2 by 11 inches and 17 by 22 inches. The publications may be requested by sending an e-mail message to inquiries@nist.gov, by calling (301) 975-NIST (6478), or by faxing a request to (301) 926-1630.

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ALGORITHM DEVELOPED FOR MINIMIZING CUMULATIVE TIME-BASE QUANTIZATION ERRORS

Researchers at NIST have developed a new technique for modeling and implementing a method for minimizing the quantization errors that often accumulate in electronically generated time bases. A NIST scientist working with staff from Ohio University, examined how time-base distortion causes nonlinear distortion of the electrical waveforms measured by digital sampling instruments, such as digital voltmeters and multimeters, sampling waveform recorders and oscilloscopes. When such instruments are used to measure the rms amplitude of the sampled waveforms, such distortions cause significant errors in the measured rms values of the waveforms.

In particular, the research examined the nature of the errors that result from nonrandom quantization errors in an instrument's time-base circuit. Simulations made for a sampling voltmeter showed that the errors in the measured rms amplitude have a non-normal probability distribution, such that the probability of large errors is much greater than would be expected from the usual quantization noise model. A novel time-base compensation method was then proposed that makes the measured rms errors normally distributed and reduces their standard deviation significantly. This quantization method is referred to as the cumulative-sum-limited (CSL) quantization scheme.

As a vehicle for implementing the CSL algorithm, a NIST scientist then applied it using the data acquisition software that he had developed in conjunction with the NIST Wideband Sampling Voltmeter (WSV). The result was that this scheme turned out to reduce the time-base quantization error by a factor of 25. A paper describing this research was presented at the IEEE Instrumentation and Measurement Technology Conference (IMTC) 2000 held in Baltimore, MD, and will appear in the August 2001 Special Issue of the *IEEE Transactions on Instrumentation and Measurement.*
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EVALUATION OF ELECTROMAGNETIC COMPATABILITY (EMC) COMPLIANCE CHAMBERS

NIST staff presented a paper, *Evaluation of an EMC compliance chamber using an ultrawideband measurement system,* at the Antenna Measurement Techniques Association meeting in Philadelphia. This technique summarized the results of a joint NIST-industry measurement effort that was carried out to develop fast and low-cost absorber-lined chamber evaluation techniques. This effort was in response to the fully anechoic room (FAR) proposal that is currently being considered by the European Community (CENELEC & IEC). The NIST team studied the FAR proposals and saw that the proposed measurement techniques were costly, cumbersome and time-consuming. In addition, the quasi free-space reference defined in the document presents a major safety hazard since it requires measurement personnel to operate at heights in excess of 8 m. The NIST measurement system eliminates the need for a quasi free-space reference, and significantly reduces measurement time and associated costs. The key to this system is the use of NIST-developed transverse electromagnetic horn antennas with a short impulse response duration that permits the use of time gating to obtain an equivalent free-space reference. The ability of the NIST system to resolve scatterers within the chamber environment system represents a quantum leap forward in chamber evaluation technology.
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LTCC SUBSTRATES CHARACTERIZED AT HIGH FREQUENCIES

NIST staff recently completed measurements that resulted in a broadband characterization of the permittivity, loss tangent, and metal-loss of several classes of Low Temperature Co-Fired Ceramics (LTCC) substrates. The manufacturers of LTCC substrates expressed a need for improved measurement methods for characterizing the electromagnetic properties of LTCCs at a NIST-industry LTCC workshop held in Gaithersburg, MD, in October 1999. LTCC materials are increasingly being used in wireless and interconnect applications because of their ruggedness, high thermal conductivity, and low expansion coefficient. LTCC manufacturers need accurate permittivity and loss tangent measurements at microwave frequencies for use in CAD circuit design.

In response to this expressed need, NIST is working together to support the materials design and measurement needs of the emerging LTCC industry. Using the split-cylinder, split-post, and Fabry-Perot resonator methods, NIST scientists characterized substrates over a frequency range of 1 GHz to 60 GHz. The LTCC manufacturers are using the results of these measurements to verify their own permittivity and loss tangent measurement capabilities.
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IEC TECHNICAL COMMITTEE, LED BY NIST, PUBLISHES FOUR NEW SUPERCONDUCTIVITY STANDARDS

Four new international standards on superconductivity were recently published by the International Electrotechnical Commission (IEC) Technical Committee 90 (TC 90). The documents are:

- IEC 61788-3 Superconductivity—Part 3: Critical current measurement—DC critical current of Ag-sheathed Bi-2212 and Bi-2223 oxide superconductors,
- IEC 61788-5 Superconductivity—Part 5: Matrix to superconductor volume ratio measurement—Copper to superconductor volume ratio of Cu/Nb-Ti composite superconductors,
- IEC 61788-6 Superconductivity—Part 6: Mechanical properties measurement—Room temperature tensile test of Cu/Nb-Ti composite superconductors, and
- IEC 60050-815 International Electrotechnical Vocabulary—Part 815: Superconductivity.

NIST scientists have worked extensively on these documents and helped resolve many difficulties encountered during the development process. A NIST scientist serves as chairman of TC 90 and manages the international work. Eleven countries participate in TC 90. The vocabulary was created under TC 90, but all

vocabulary publications are listed under TC 1. This vocabulary contains 301 terms and their definitions. The standard on the critical current of oxide superconductors is the first IEC standard on the newer high-temperature superconductors. This brings the number of IEC TC 90 published standards to six. Currently, eight more documents are at various stages of development within TC 90.
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NIST CO-SPONSORS GOVERNMENT-INDUSTRY IT SECURITY FORUM

NIST and the National Security Agency (NSA), partners in the National Information Assurance Partnership (NIAP), hosted a Government-Industry IT Security Forum in March 2001, at Indiana University. The purpose of the forum was to discuss potential public and private sector strategies for the development of IT security requirements and security specifications needed for the protection of government, business, and personal computing and real-time control systems. The forum brought national attention to the concept of security requirements definition and its importance in developing a more secure information infrastructure within the U.S. Some 175 participants heard key leaders from government, industry, and academia share their views on the role of security requirements in the development, testing, and acquisition of commercial products and systems. There was also discussion on prospective approaches to security requirements development, the importance of national and international standards, cost-effective and timely testing strategies, and the use of state-of-the-art tools and techniques in this area.

The NIAP IT Security Forum followed the First Symposium on Requirements Engineering for Information Security (SREIS) hosted by the Purdue University Center for Education and Research in Information Assurance and Security (CERIAS) in cooperation with NIST, the North Carolina State University (NCSU) E-commerce program and the Association for Computing Machinery (ACM). The Web site is http://niap.nist.gov.
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NIST HOSTS WORKING GROUP MEETING ON ITL BIOMETRICS INITIATIVE

In February 2001, the Biometric Interoperability, Performance, and Assurance Working Group held its second meeting at NIST. Sponsored by NIST and the Biometric Consortium, the group is developing a simple testing methodology to determine the performance of biometric systems, as well as addressing issues on biometric assurance. In addition, the group is focusing on the use of biometrics data in smart card applications by developing a smart card format compliant to the Common Biometric Exchange File Format (CBEFF), another NIST initiative (www.nist.gov/cbeff). NIST plans to validate the testing methodology and implement tests on the CBEFF smart card format in its Biometrics and Smart Cards Laboratory.

The NIST initiative promotes exchange of information and collaborative efforts between users and private industry in all things biometric and supports the advancement of technically efficient and compatible biometric technology solutions on a national and international basis. The group consists of 65 participants representing over 50 national and international organizations from the U.S., Australia, Italy, South Korea, UK, Canada, Sweden, and France. Member organizations include biometric vendors, system developers, information assurance organizations, commercial end users, universities, government agencies, national laboratories, and industry organizations. The Web site is: www.nist.gov/bcwg.
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INTERNATIONAL STANDARDS FOR THERMAL PROPERTIES OF POLYMER MELTS

NIST scientists recently participated in an international round-robin study of the thermal properties of polymer melts, organized by the National Physical Laboratory (NPL) in the United Kingdom. The polydimethylsiloxane (PDMS) sample was studied at seven laboratories around the world, with the results summarized in NPL Report CBTLM S35 published in December 2000. The NIST measurements of the thermal conductivity of liquid PDMS cover the temperature range of reference data used to calibrate thermal conductivity apparatus at temperatures up to 700 K. The NIST data were measured with an absolute transient hot-wire instrument and are the only data available on the PDMS sample at temperatures above 420 K. The agreement between five participating laboratories and the ASTM (D5930-97) recommended value at 298 K is within ± 2 % for the thermal conductivity of this sample of PDMS. The NIST measurements supplement existing reference data for the thermal conductivity of liquids, such as water (273 K to 370 K, IUPAC-1993), toluene (300 K to 550 K, IUPAC-2000), and dimethylphthalate (273 K to 473 K, ASTM D2717-95). These new data improve instrument calibrtions following the ASTM Standard

Test Methods D27170-95 for the thermal conductivity of plastics.
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AT CONFERENCE, THE "P" IN PC STANDS FOR "PERVASIVE"

The era of pervasive computing is approaching as researchers find more ways to combine computers, sensors, communications devices and the Internet.

NIST sponsored the second annual Pervasive Computing 2001 conference in May 2001, to focus on the challenges industry faces in developing practical and cost-effective applications for these new technologies. Conference participants will examine technologies ranging from mobile voice recognition to smart office spaces. Additionally, some sessions will focus on particular emerging applications, such as wireless ticketing and mobile commerce.

Leaders in applications and technology from industry, academia and government will make presentations about their goals, approaches, products and projects, as well as discuss how they plan to deploy future pervasive computing systems.

Pervasive Computing 2001 was be held at NIST's campus in Gaithersburg, MD. More information is available at www.nist.gov/pc2001.
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PAPER DESCRIBES NIST SUPPORT FOR OPTICAL FIBER INDUSTRY

In response to rapid changes in fiber optic technology, NIST is developing techniques and standards to support the measurement of optical components and subsystems used in wavelength division multiplexed (known as WDM) optical fiber communication systems. A new paper describes the development of wavelength calibration transfer standards and the accurate measurement of spectral response, dispersion, and polarization dependence of optical fiber and components.

In the area of wavelength calibration, NIST has developed Standard Reference Material (SRM) transfer standards based on rotational-vibrational transitions in acetylene and hydrogen cyanide molecules. The SRMs were designed for calibrating wavelength-measuring instruments such as optical spectrum analyzers and wavelength meters. New work is focused on molecules of carbon monoxide as an SRM for the new WDM-L band.

NIST's spectral measurement system uses the calibrated wavelength meter and a tunable diode laser source to measure the transmittance and reflectance of WDM components. Wavelength filters are needed to remove amplified spontaneous emission produced by the diode laser. NIST recently conducted a round robin measurement intercomparison to assess current measurement capabilities for wavelength filters. The agency is working with the Telecommunications Industry Association to develop standard test procedures and evaluate measurement capabilities.

Concerning chromatic dispersion, NIST has developed two systems to measure relative group delay which broadens pulses and limits the system data rate. One system is based on low-coherence interferometry; the other is a more conventional rf-modulated phase-delay method. After compensating for chromatic dispersion, the next significant mechanism for pulse-broadening is polarization-mode dispersion (PMD). NIST supports PMD metrology through two SRMs—SRM 2518, Polarization-Mode Dispersion (Mode-Coupled) and SRM 2538, Polarization-Mode Dispersion (Non-Mode-Coupled).

The paper describing this work, No. 02-01, is available free of charge by contacting Sarabeth Harris, NIST, MC104, Boulder, CO 80305-3328; (303) 497-3237; sarabeth@boulder.nist.gov.
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CONFERENCE SEEKS IT ACCESS FOR ALL

Scientists and engineers are developing a variety of ways to make computers and other information age devices easier for people with disabilities to use. Yet advocates for the disabled say that information technology companies and government agencies could do more.

NIST held a conference to explore the issues and challenges involved in making accessibility a reality, with a focus on industry and government goals, challenges and strategies.

IT Accessibility 2001 brought accessibility leaders in industry, government, and academia together with advocates for people with disabilities. The conference, held in May 2001, at NIST's headquarters in Gaithersburg, MD, covered topics such as World Wide Web accessibility, economic incentives for creating accessible products and services, legislative trends and federal accessibility regulations (with emphasis on Section 508 requirements).

Speakers represented a variety of organizations, including the Center for Applied Special Technology, the Information Technology Association of America, the National Center for Accessible Media, and many others.

NIST has long played a pioneering role in making technology more accessible to a variety of people. For example, NIST research led to the development of the closed captioning system for television. NIST shared an Emmy Award for outstanding achievement in engineering development in 1980.

More recently, NIST developed an inexpensive prototype Braille reader that translates digital data into Braille characters. Researchers created the system as part of a project to make electronic books more accessible to the blind and visually impaired.

More information is available on the IT Accessibility 2001 web site at www.nist.gov/ITaccess2001.
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PRACTICE GUIDE ON PARTICLE SIZE CHARACTERIZATION NOW AVAILABLE

The first in a new publication series, the *NIST Recommended Practice Guide: Particle Size Characterization,* will help industrial and academic laboratories measure particle size and size distribution of ceramic powders in a more reliable and reproducible way. Improper powder size measurements during processing can affect the mechanical, electrical or thermal properties of the final product, resulting in poor quality and high rejection rates. Designed for a general user, the guide includes aspects of particle characterization research conducted by NIST for well over a decade. This research also has resulted in the development of standard reference materials and improvements in measurement procedures.

The guide covers techniques commonly used in the ceramics manufacturing industry such as microscopy, sieving, gravitational sedimentation and laser light diffraction. For each technique, the book provides directions for sample preparation, instrument calibration and set-up; details relevant national and international standards; and discusses capabilities, limitations and general principles.

NIST researchers are looking at the challenges presented in the characterization of smaller-size (submicrometer or nanometer) particles. These powders typically are used in the manufacture of components, such as substrates for computer chips and high-temperature structural materials. NIST plans to hold a workshop on issues related to reliable particle size measurement at the submicrometer and finer levels in October 2001.

To obtain a copy of NIST Special Publication 960-1, *NIST Recommended Practice Guide: Particle Size Characterization,* contact Carolyn Sladic, (301) 975-6119, carolyn.sladic@nist.gov. For more information on NIST particle research, contact Ajit Jillavenkatesa, (301) 975-5089, ajit.jilla@nist.gov.
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PAPER TRACES HISTORY OF NIST REFRIGERANTS PROGRAM

A new paper traces the history of NIST's research on the thermophysical properties of refrigerants. In 1909, when the agency was only 8 years old, the American Society of Refrigeration Engineers (now the American Society of Heating, Refrigerating and Air- Conditioning Engineers) asked the then-National Bureau of Standards (NBS) to determine the properties of calcium chloride brines. Four years later, it asked NBS to do research on ammonia; the tables resulting from this work, published in 1923, remained the accepted properties for this important fluid until superseded by another NBS formulation in 1978.

Other early work of interest to the refrigeration industry included determination of the specific and latent heats of ice and properties of steam. Some of these early data for ammonia and steam, most notably the heat capacity and heat of vaporization data, still are considered to be among the very best available.

In the 1950s, some of this work transferred to the new NBS laboratory in Boulder, CO. Its early work addressed the needs of the space program for thermophysical properties of hydrogen, oxygen, and other fuels and oxidizers. Later, the program focused on simple hydrocarbons and their mixtures, and other fluids of industrial interest.

The current program began in 1981 as a collaboration between NBS Boulder and NBS Gaithersburg groups to provide properties for refrigerant mixtures being investigated for use in heat pumps. The program increased dramatically in scope 6 years later when chlorofluorocarbon refrigerants were implicated in destruction of stratospheric ozone. Because of its long-standing research in fluid properties, NIST was in a unique position to respond to the urgent international need for data on new refrigerants. NIST transfers this data to industry in a variety of ways, including a computer database known as REFPROP.

For a free copy of paper No. 10-01 describing this history, contact Sarabeth Harris, NIST, MC104, Boulder, CO 80305-3328; (303) 497-3237; sarabeth @boulder.nist.gov.
Media Contact: Fred McGehan (303) 497-3246; mcgehan@boulder.nist.gov.

NEW EXCIMER LASER MEASUREMENT SERVICE AVAILABLE

NIST recently has developed a new excimer laser measurement service for small-area detectors like those used in high-resolution semiconductor photolithography systems, and other excimer laser applications.

NIST now has the capability to accurately measure pulse-energy density of deep ultraviolet radiation produced by excimer lasers; this new capability is being used to provide dose (i.e., energy density) measurement services. NIST offers absolute responsivity calibrations of laser dose meters at the laser wavelength of 193 nm. Additional excimer laser wavelengths will be added to this service in the near future.

The dose measurements are performed using a beam-splitter-based calibration system in which a spatially uniform beam from an argon-fluoride excimer laser is generated using a special beam homogenizer. The beam propagation properties, including uniformity or homogeneity, are fully characterized with a state-of-the-art beam profile measurement system based on a pyroelectric camera array. This uniform beam then is used to irradiate a NIST-calibrated aperture placed immediately in front of the test detector. Measurement traceability for these calibrations comes from an electrically calibrated, primary standard calorimeter developed by NIST.

Additional information on this new calibration service can be obtained from Richard D. Jones, MC 815, NIST, Boulder, CO 80305-3328; (303) 497-3439; rdjones@boulder.nist.gov.

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THIRD PATENT FOR NIST'S ROLE-BASED ACCESS CONTROL WORK

On March 3, 2001, patent #6,202,066 was issued to NIST for "Implementation of Role/Group Permission Association Using Object Access Type." This is the third patent issued to NIST for work in Role Based Access Control (RBAC). The first two are #6,023,765 and #6,088,679.

NIST work in RBAC began almost 10 years ago. At that time, there were almost no products that used RBAC, and the concept of using roles for access control was not well defined. NIST published a model for RBAC in 1992 and refined the model and published a semiformal description in 1995. Since then, formal descriptions of the model and reference implementations have been developed and published.

In RBAC, access decisions are based on the roles that individual users perform within an organization. Users take on assigned roles (such as doctor, nurse, teller, or manager). The process of defining roles should be based on a thorough analysis of how an organization operates and should include input from a wide spectrum of users in an organization. Access rights to operations on objects are grouped by role name, and the use of resources is restricted to individuals authorized to assume the associated role. For example, within a hospital system, the role of doctor can include operations to perform diagnosis, prescribe medication, and order laboratory tests; and the role of researcher can be limited to gathering anonymous clinical information for studies.

The use of RBAC can reduce the cost and the errors associated with managing user access to objects. The principal motivation behind RBAC is the desire to specify and enforce enterprise-specific security policies in a way that maps naturally to an organization's structure. Traditionally, managing security has required mapping an organization's security policy to a relatively low-level set of access controls. With RBAC, it is not necessary to translate an organizational view into another view in order to accommodate an access control mechanism. In RBAC, the natural organizational view is the access control mechanism. The web site is http://hissa.nist.gov/ rbac/.

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NON-LINEAR OPTICAL CHARACTERIZATION OF GALLIUM NITRIDE AIDS MATERIAL IMPROVEMENT

Gallium nitride and related alloy materials are making enormous economic impact with the realization of semiconductor lasers and light-emitting diodes emitting in the blue for data storage, solid-state lighting, and displays. However, problems with material quality remain, particularly in the case of substrates. Furthermore, the lack of a reliable database for the linear optical properties of the group III-nitrides is hampering development of engineering design tools. A NIST scientist has applied non-linear optics (NLO) to the characterization of gallium nitride grown by industry and university collaborators. NLO offers rapid and versatile measurement capabilities that can be used to examine materials at various stages of crystal growth and device processing. Furthermore, material uniformity evaluated using NLO methods has been correlated directly with the information derived from analytical methods that are not conveniently adapted to the manufacturing environment.

NLO was used to compare the optical and structural properties of GaN bulk crystals grown by high- pressure processing, and thin films of the material grown by hydride vapor phase epitaxy, metal-organic chemical

vapor deposition, and molecular beam epitaxy. The results show distinct variations in both the index of refraction and the magnitude of the non-linear optical coefficients, depending on the growth method. The refractive index measurements were verified by a prism-coupling technique. NLO is extremely sensitive to such undesirable structural features as stacking faults, domain reversals, and mixed cubic and hexagonal phases. The presence of stacking faults and other mixed phases was revealed in transmitted second-harmonic generation (SHG) by the appearance of extra SHG polarization components that would not occur if the material had purely a single-phase hexagonal structure. High-resolution x-ray diffraction imaging measurements revealed full-crystal images of stacking faults and domain reversals. However, the x-ray technique is less sensitive to the presence of mixed phases. Thus, a combination of NLO analysis and x-ray imaging methods resulted in reduced ambiguity compared to the case if only one method was employed. The results of both are being used to help gallium nitride suppliers improve material quality for future generations of devices.
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NIST'S CRYPTOGRAPHIC MODULE VALIDATION PROGRAM ADDS WEB ACCESS FOR SECURITY POLICIES

In April 2001, NIST updated its Cryptographic Module Validation Module (CMVP) web pages to allow convenient user access to all of the Federal Information Processing Standard (FIPS) 140-1 validated cryptographic module security policies. Making this information available online streamlines and reduces internal workload in fulfilling requests for distribution of non-electronic security policies.

A security policy is included in the documentation provided by a vendor for each validated cryptographic module. There are two major reasons for developing and following a precise cryptographic module security policy:

- To provide a specification of the cryptographic security that will allow individuals and organizations to determine whether a cryptographic module as implemented satisfies a stated security policy; and
- To describe to individuals and organizations the capabilities, protection, and access rights provided by the cryptographic module, thereby allowing an assessment of whether the module will adequately serve the individual or organizational security requirements.

The FIPS 140-1 Validated Modules List has become a "Who's Who" of cryptographic and information technology vendors and developers from the U.S., Canada, and abroad. The list contains a complete range of security levels and a broad spectrum of product types, now including PDAs in addition to secure radios, Internet browsers, VPN devices, PC Postage equipment, cryptographic accelerators, and secure tokens.

The CMVP is a joint effort between NIST and the Communications Security Establishment (CSE) of the Government of Canada. NIST and CSE serve as the validation authorities for the program. The web site is http://csrc.nist.gov/cryptval.
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NIST WEB METRICS TESTBED RELEASED

A new NIST Web Metrics Testbed has been released. Release 2.0 includes enhancements to existing tools, Windows versions, and new prototypes. The Web Metrics Testbed project focuses on experimenting with innovative tools to help with rapid, remote, and automated usability testing and evaluation of web sites. The testbed is designed to help usability engineers evaluate and improve the usabil-ity of their web sites. Collaboration with industry and academia continues to be an important part of the development of the testbed.

Available for downloading at http://www.nist.gov/webmetrics, NIST Web Metrics Testbed, Release 2.0, includes the following enhancements:

- Web Static Analyzer Tool (WebSAT 2.0), which checks web page HTML against typical usability guidelines;
- Web Category Analysis Tool (WebCAT 1.1), which allows the usability engineer to construct and conduct a web category analysis;
- Web Variable Instrumenter Program (WebVIP 2.0), which instruments a web site to capture a log of user interaction;
- Framework for Logging Usability Data (FLUD 1.0), which provides a file format and parser for representation of user interaction logs; and
- VisVIP Tool (VisVIP 2.0), which includes 3D visualizations of user navigation paths through a web site.

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NIST ADVANCED RADIOMETER CALIBRATED AND DELIVERED TO NASA

NIST staff recently completed a radiometric calibration of an advanced spaceflight instrument for NASA. The instrument, Scripps-NISTAR (NIST Advanced Radiometer), was developed to fly as part of the NASA Triana mission, which will view Earth from an L1 orbit (the Lagrange libration, or neutral gravity point between the Earth and the Sun)—about 1.5 mullion kiolometers from Earth. from there, an imaging camera and NISTAR will have a continuous, full, sunlit view of the Earth. NISTAR includes three active cavity electrical substitution radiometers for absolute irradiance measurements, and one silicon photodiode.

To properly simulate a sunlit Earth in the calibration laboratory, NIST researchers used NIST's SIRCUS (Spectral Irradiance and Radiance Responsivity Calibrations with Uniform Sources) facility. A tunable laser was fiber-optically coupled to an integrating sphere, which then served as a unform diffuse source of tunable monochromatic light, and the geometry was designed to provide the required 0.5° field of illumination. The NISTAR instrument's optical responsivity and other characteristics were measured using a wide variety of laser wavelengths in the range 488 nm to 850 nm (blue, green, red, near-infrared). during these tests, the NISTAR instrument was in a space-simulating thermal vacuum chamber, viewing the SIRCUS light through windows. This was the first time that the SIRCUS facility was used for an instrument in such a chamber. The results show that various adverse radiometric effects from using winddows and translating the fiber-optically coupled sphere are minimal and the resulting calibrarion uncertainties are below 1 %.

The NISTAR instrument was delivered to the NASA Goddard Space Flight Center and is ready for integration with the remaining spacecraft components for the Triana. To obtain additional information about the Triana mission, or to view the spacecraft's integration and testing pahse, visit http://trianaweb.gsfc.nasa.gov/

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NEUTRONS USED TO CHARACTERIZE A NOVEL LITHIUM-CONTAINING ZEOLITE

Zeolites are minerals with molecule-sized pores. Different materials have different-sized pores. In the past few decades, chemists have learned to produce new zeolite analogs that incorporate a variety of elements and have a variety of properties. These zeolitic materials are used widely for tasks ranging from the production of gasoline and medcal ocygen to improved laundry detergents.

In collaboration with researchers from SUNY Stony Brook and the Ruhr-Universität-Bochum, MSEL researchers have characterized a new type of zeolitic material—the lithosilicate RUB-29—built in part from LiO_4 building blocks. [S.-H. Park et al., *Journal of the American Chemical Society,* **122**, 11023 (2000).] Neutron diffraction performed at NIST was essential for a complete structural determination for this material. The novel LiO_4 building units found in RUB-29 are more flexible than others previously employed and allow formerly impossible configurations of pores to be achieved. Also, the Li atoms require proportionally more charge balancing cations than other building blocks. This means that lithosilicates have the potential for unprecedented ion-exchange capabilities. Further, in this work, an additional unique property of RUB-29 was discovered: the Li atoms in this material are mobile at relatively low temperature (<250 °C), indicating this class of materials could have possible applications in fuel cell or battery technology.

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RESEARCHERS DEVELOP NEW TRANSIENT THERMAL IMAGING SYSTEM

NIST researchers have produced a new system that enables, for the first time, the precise measurement of high-speed transient thermal images. The new system is several orders of magnitude faster than conventional infrared thermal imaging systems and provides the capability to measure the transient temperature distributions on the surface of a semiconductor chip with 1 ms time, and 15 mm spatial resolution.

The new transient thermal imaging system uses computer-control software with a graphical user interface for controlling the translation stages, digitizing oscilloscope, and device test fixture temperature controller. The system enables the observation of semiconductor device dynamic heating that can lead to failure events and enables the localization and shape determination of small heat sources before the heat has time to diffuse to surrounding areas.

The system allows the display of the temperature-transient waveform for a single point, or a temperature map of the entire imaged chip region. A unique feature of the system is a movie-playback mode that permits viewing the area map under dynamic heating and cooling conditions. The utility of the system was demonstrated using a bipolar transistor hotspot current constriction process. A paper detailing the results was published recently in the proceedings of the Seventeenth Annual IEEE Semiconductor Thermal Measurement and Management Symposium.

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QUALIFICATION OF EMC TEST SITES

NIST has developed a scattering experiment to explore electromagnetic compatability (EMC) test site qualification using double-ridged horn antennas. The test procedure consisted of six steps in which a metal plate was placed in close proximity to a site quality measurement system to quantify its impact. Personnel from NIST, industry, and Underwriters Laboratories conducted the test plan. The results were presented at the ANSI 1-13.2 working group meeting on radiated emission test site quality above 1 GHz in Piscataway, NJ. Results were obtained in a wide variety of EMC test facilities as well as an ordinary room environment using several different measurement systems. The results were conclusive: they clearly demonstrated that the current low-frequency facility evaluation methods as defined in the IEC/ CISPR 16 and ANSI C63 standards are not applicable to directional horn antennas. This effort highlights the need for more aggressive test procedures, which are currently being developed by NIST researchers in conjunction with the working group. NIST staff presented a paper on their research at the IEEE EMC Society workshop held at the Zurich EMC symposium. The international community responded well to the results of this effort, and the United States established a leadership role in this important area.
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ULTRACOLD NEUTRAL PLASMAS CREATED AT NIST

On Earth, most material exists as either a solid, liquid, or gas, made up of electrons and ions bound to each other in neutral atoms and molecules. However, most matter in the universe exists as plasma, in which electrons and ions move as free charged particles. Familiar plasmas are relatively hot, such as in the solar corona (1 000 000 K), fluorescent light bulbs (10 000 K), or the ionosphere around the Earth (1000 K). NIST researchers have created ultracold plasmas at temperatures as low as 1 K. They use lasers to trap and cool (to less than 0.00001 K) a few million neutral xenon atoms, and then illuminate the cloud with a pulse of laser light containing just enough energy to unbind electrons and ions and create the plasma. Little is known about plasmas in this new regime. The researchers have measured how the plasma freely expands and discovered an unexpected source of expansion energy that they believe is tied to the recombination of the electrons and ions into neutral atoms—the lowest energy state of the system. At high temperatures, this recombination takes a long time and plasmas can be long-lived. Recent experiments reveal that, as the ultracold plasma expands, the rate of recombination is much larger than expected; the results differ so greatly from behavior in hot plasmas that no current theory can describe the results. Further study is motivated not only by fundamental interest but also because experiments may shed light on the physics of dense cores of gas giant planets like Jupiter, or guide efforts to create anti-hydrogen through the recombination of positrons and anti-protons.
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THICKNESS VARIATIONS MEASURED IN SILICON WAFERS

A NIST scientist completed testing of an IR (infrared) Interferometer to investigate the effect of the 8 mm diameter vacuum holder on the locally measured thickness variation of "free-form" silicon wafers. The combination of wafer thickness variation measurements (performed in the IR) and chucked wafer flatness measurements (performed with a visible He-Ne source) help in the deduction of the flatness of the vacuum chuck. Chuck flatness is an important consideration for the semiconductor industry. The measurement technique (sometimes referred to as Haidinger fringes) analyzes interference fringes from the front and back surfaces of the wafer. The test results show a low sensitivity to macro-level wafer distortions. An 8 mm diameter vacuum orifice is used to hold wafers during the free-form measurements. When measured with visible surface reflections, the orifice impression caused a nearly 2 μm "drum-type" deflection of the nominally parallel faces of a 400 μm thick wafer. However, the phase map measured using the new Haidinger fringe technique demonstrated no observable local effects in the wafer thickness variation. Thus, the vacuum orifice holding technique does not impact the measurement results of wafer thickness variation.
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NEW "MODEL FUNCTION" FOR SEM IMAGES OF DENSE LINES

Improved software for constructing predicted scanning electron microscope (SEM) images of line features has been produced. Given a set of parameters describing sample geometry and instrument settings, the software quickly predicts the image that would be observed in the SEM by using piecewise assembly of features from a precomputed library of edge shapes. A similar model was fit recently to measured SEM linescans of an isolated polycrystalline silicon line. The new model

function is a generalization of the previous one, with additional capabilities in two important areas. First, it is not restricted to single linescans—it can produce a multi- linescan SEM image in which geometrical parameters describing the sample can vary with position while instrument parameters remain the same for the whole image. This should reduce the number of extraneous parameters when performing least squares fits, thereby improving the significance of the remaining parameters. Second, it is not restricted to samples with a single iso-lated silicon line but can model dense repeated structures that are often important in semiconductor manufacturing. The model function is the first of three pieces required to determine sample geometry and instrument parameters by least squares fitting. Such fitting requires (1) the model function, (2) a residuals function that subtracts a model result with given parameters from measured data, and (3) a non-linear least squares part that adjusts the parameters to minimize the sum of squares of residuals.
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IMPROVED STATISTICAL ANALYSIS TOOL

Calibrating the scale factor of the NIST Ultraviolet (UV) Microscope requires determining the regression slope for UV Microscope measurements on a traceable reference standard. The uncertainty of this slope is the Type B uncertainty component for the traceability of the Standard Reference Material (SRM) 2800s calibrated on this instrument. This slope uncertainty depends on the combined expanded uncertainty of the reference data as well as the variance of the regression residuals. There was no standard solution to this problem, so NIST statisticians developed a new method for determining the uncertainty of a regression slope for data characterized by standard uncertainties.
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PRELIMINARY COMPARISON RESULTS OF Nano3 LINE SCALES SHIPPED

In a meeting held at Bureau International des Poids et Mesures (BIPM) in June 1998, the Consultative Committee for Length (CCL) and Working Group on Dimensional Metrology (WGDM)-7 decided to conduct preliminary comparisons for five different types of artifacts. Among the five different artifacts were the Nano3 Line scales. Fourteen national laboratories around the world participated in this comparison with Physikalisch-Technische Bundesanstalt (PTB), Germany, acting as the Pilot Laboratory. These comparisons will help to establish the degree of metrological equivalence between the participating nations. The NIST Nano-Scale Metrology Group completed measurements for this key international comparison of line scales and sent the final measurement reports to PTB. Two 280 mm scales, one Zerodur and one quartz, were measured on the NIST Line Scale Interferometer (LSI). These scales were shipped around to the participating laboratories in a precision shipping container, which was equipped with temperature, humidity, and shock sensors; the outputs from these sensors were recorded by the on-board data logger.
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NIST A SPONSOR OF SECOND INTERNATIONAL CONFERENCE ON OXIDATIVE STRESS AND AGING

An international meeting entitled "Second International Conference on Oxidative Stress and Aging: Technologies for Assessment and Intervention Strategies," took place in Maui, HI, in April 2001. This international meeting, part of the Oxidative Stress and Aging Associations series, focused on the latest research on molecular gerontology with emphasis on oxidative stress-related mechanisms of aging and longevity determinants. The conference showcased the latest non-invasive methods designed to measure oxidative stress in humans for clinical purposes and provided a review of the latest intervention strategies designed to control oxidative stress through dietary and/or pharmacological means. Additionally, the need and criteria for the development of measurement standards, guidelines, and best practices in measuring human oxidative stress parameters and dietary/pharmacological supplements were addressed at the conference.

The conference was host to scientists from academia, government, biotechnology, and pharmaceutical organizations and was held in the state of Hawaii, where life expectancy is among the highest in the world, and where a quarter of state's residents will be at least 60 years of age within 25 years. The conference was sponsored by 17 organizations including NIST, and was attended by more than 200 people throughout the world. It comprised 48 invited talks, three poster sessions consisting of a total of 104 posters, and two oral poster presentations by postdoctoral students. A unique feature of the conference was the "Ask the Expert" luncheon roundtables where registrants had the opportunity for an informal lunch with one of that days lecturers and to submit questions and raise issues on the experts field of specialty.
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DIGITAL LIBRARY OF MATHEMATICAL FUNCTIONS PROFILES IN PHYSICS PUBLICATIONS

The April 2001 issues of the two widely circulated physics magazines, *Physics Today* and *Physics World,* each have articles referring to the NIST Digital Library of Mathematical Functions (DLMF) project. *Physics World* featured a full-page news article on the DLMF project (p. 9) entitled "The bible for theorists goes electronic." The article in *Physics Today* addresses the need for mathematical handbooks in physics. This article is available online at http://physicstoday.org/pt/vol-54/iss-5/p11.html.

The DLMF will be an interactive, richly linked, network-based resource of mathematical reference data of use in a wide variety of fields. Freely accessible on the web, the DLMF will provide some of the basic infrastructure needed by the technical community to integrate modern information technology more fully into its day-to-day work. The digital library will replace the classic *Handbook of Mathematical Functions,* NBS Applied Mathematics Series 55, published in 1964. This reference, which has sold an estimated 600 000 copies and is still in print, contains formulas, graphs, and tables, which characterize the higher functions of applied mathematics. these functions (often known as special functions) are used extensively in mathematical analysis in many fields, such as physics and chemistry, and they are essential tools in modern computational modeling of phenomena in the physical sciences and engineering. The web site is http://dlmf.nist.gov/.

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NIST TAKES OVER AS MPEG WEB SITE HOST

NIST is now hosting the World Wide Web site for the Moving Picture Experts Group (known as MPEG), which develops the most widely used international standards for multimedia, video, music and audio.

The current MPEG site has been hosted by a private company for 5 years. It includes working group documents, contributions from industry, experimental information and software. This allows people involved in the standards development process to upload and share information.

Plans for the NIST MPEG Web site include a search and retrieve capability for the online document archive, an automated document upload and registry process, virus checking on incoming files and the ability to track membership and ad-hoc groups.

MPEG is the working group of the International Organization for Standardization (known as ISO) and International Electrotechnical Commission that develops standards for coded representation of digital audio and video. Established in 1988, the group has produced MPEG-1, the basis for MP3; MPEG-2, the basis for DVD; and MPEG-4, a multimedia standard. The MPEG Committee received an Emmy Award from the Academy of Television Arts and Sciences in 1998 for its work on MPEG-1 and MPEG-2.

The current focus is on MPEG-7, the "Multimedia Content Description Interface," which will be completed this year. This version of MPEG will allow the full search and retrieval of multimedia objects using its standardized description language based on XML.

The MPEG site, which is only open to technical experts and requires a password for entry, is at http://mpeg.nist.gov. Information on how to obtain a user name and password is available by sending an e-mail to mpeg@nist.gov. A public Web site with background information about MPEG is at www.cselt.it/mpeg.

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JUNE WORKSHOP EXAMINES DRAFT LANGUAGE FOR MATERIALS DATA EXCHANGE

At a workshop scheduled in June 2001, an international working group of materials scientists and engineers will present the draft of new software—Materials Markup Language, or MatML—designed to facilitate the exchange of data on materials and their properties over the Internet. Representing industry, national laboratories, universities and standards and professional organizations, the working group will seek input from participants on the technical aspects and strategic direction of MatML.

Addressing the problems of data interpretation and interoperability among different computer systems, MatML will provide a standard format for exchanging materials property data on the World Wide Web, enabling researchers to understand and use data from various sources. Based on the eXtensible Markup Language (known as XML), MatML provides a scheme for describing data with consistent tags, which will lead to the transfer of materials data directly into other computer applications, such as modeling, simulation or databases, without the need for human intervention.

The workshop was held at NIST's Gaithersburg, MD, headquarters. NIST has been coordinating the MatML development effort for the past 18 months.

For more information about the MatML software development effort, contact Ed Begley, (301) 975-6118, begley@nist.gov.

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GROUP WANTS TO MAKE "E-BUSINESS" AS EASY AS "A-B-C"

Computer scientists at NIST have been participating with the information technology/electronic commerce industry in the development of a set of emerging, global e-commerce standards. These standards comprise electronic business XML (known as ebXML), a joint effort sponsored by the Organization for the Advancement of Structured Information Standards and the United Nations Centre for Trade Facilitation and Electronic Business.

The goal of ebXML is to specify an e-commerce infrastructure where enterprises of any size and in any geographical location conduct business with each other. ebXML enables businesses to find partners, develop business agreements and find and process the necessary documents for business transactions—dramatically lowering the cost of exchanging business information electronically. ebXML makes use of the eXtensible Markup Language (known as XML) for the representation and exchange of documents and messages. XML, a leading industry specification for e-commerce, is a language that describes data in a way that allows computers to exchange information and automatically act on it.

NIST contributes to the development of the technical specifications for ebXML, especially in the areas of registries/repositories and conformance. The ebXML effort came to a successful conclusion at the group's May 2001 meeting in Vienna, Austria.

NIST has been at the forefront of a variety of XML efforts, including the development of software conformance tests that allow people to make sure their XML systems conform to voluntary industry standards. For more information, contact Lynne Rosenthal, (301) 975-3353, lynne.rosenthal@nist.gov

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JUNE SYMPOSIUM SHOWCASES INTERACTIVE DIGITAL TV

The arrival of interactive digital television is creating exciting opportunities for TV producers, advertisers, broadcasters, consumer electronic manufacturers, the computer industry and more than 240 million American viewers.

Interactive DTV is the convergence of traditional television, computers and the Internet. This combination will lead to new forms of electronic commerce, video-on-demand, targeted advertising, enhanced viewing experiences and broad applications such as electronic learning and health care.

NIST hosted the second annual Digital TV Application Software Environment (known as DASE) international symposium in June 2001, at the agency's Gaithersburg, MD, headquarters. The symposium on interactive TV and the emerging standards in the industry will include sessions on topics of interest to the entertainment industry, broadcasters, consumer electronics manufacturers, software developers and computer hardware manufacturers. DASE Symposium 2001 is co-sponsored by NIST and the Advanced Television Systems Committee.

More information about DASE Symposium 2001, including access to online registration and a complete agenda, is available at www.dase2001.nist.gov/. For information on the NIST and ATSC T3/S17 consortium's collaborative effort to develop a DASE standard, go to www.dase.nist.gov/.

Media Contact: Philip Bulman (301) 975-5661; philip.bulman@nist.gov.

MICROTESTER "STRESSES" ELECTRONIC PACKAGING

Throughout its 100 year history, NIST has been known as a leader in testing large objects (such as bridges, cars and sections of ship hulls) for stress and strain effects. Now, NIST at Boulder, CO, has added stress and strain testing at the other end of the spectrum with a new ability to test electronic interconnects at the micrometer level.

Today's electronic products, such as cell phones or personal computers, contain complex microchips that can be subject to the same stress and strain as a bridge girder or a train rail. To measure resistance to these stresses, NIST has developed special mechanical test apparatus and techniques. A recent technical paper discusses a microscale "skyhook" type tensile-test technique that has been used successfully to evaluate electron-beam-evaporated aluminum films with gauge sections 1 μm by 10 μm by 180 μm, under both optical and scanning electron microscopes.

The "skyhook" is a sharp-pointed tungsten rod whose tip is slightly blunted to match the diameter of a hole in the specimen. It is mounted on a base instrumented for force measurement and the combination is called the "force probe." Platforms for the microscopes used with this system accommodate a three-axis micromanipulator to hold the force probe. During the test, tension is provided by moving the appropriate axis of the micromanipulator. The force signal from the deflection of the springs on the force probe and the axial displacement of the micromanipulator are recorded several times a second. Surface images of the deforming specimen are stored every few seconds.

This procedure for tensile testing of thin films is believed to be the first that has been demonstrated to be applicable to specimens fabricated through a conventional commercial CMOS (Complementary Metal Oxide Silicon) process. The specimen footprint, approximately 400 μm by 700 μm, can be accommodated within a test chip. Only the postprocessing step to remove the silicon from beneath the specimen is nonstandard.

To obtain a copy of paper 13-01 describing the microscale tester, contact Sarabeth Harris, NIST, MC 104, Boulder, CO 80305-3328; (303) 497-3237; sarabeth@boulder.nist.gov.
Media Contact: Fred McGehan (303) 497-3246; mcgehan@boulder.nist.gov.

DATA EXCHANGE STANDARDS ADVANCE

Back-and-forth exchanges of engineering data within the complex web of makers of market-ready electronics products, contract providers of manufacturing services, and suppliers of components and materials just got easier—as well as faster, cheaper and more efficient.

These are the benefits to be gained from a new set of data-exchange interfaces devised by 16 industry, government, and university collaborators and now moving into the realm of Internet-based business practices. The so-called Product Data eXchange (or PDX) suite of specifications was developed by the Virtual Factory Information Interchange Project (VFIIP), an effort organized by the National Electronics Manufacturing Initiative (NEMI) and led by NIST and two private companies.

In late April, the first PDX specifications passed a major milestone toward widespread industry adoption. The 400-company RosettaNet consortium approved six Partner Interface Processes that are based on VFIIP-developed interfaces. These same specifications also are progressing toward formal adoption as standards by the IPC-Association Connecting Electronics Industries, a trade organization with nearly 2700 members.

Use of the VFIIP's technical outputs by both RosettaNet and IPC was pursued from the start of the project. Joint adoption ensures consistency in standards, reducing the potential for incompatibilities that undermine data exchanges and impede progress toward more effectively integrated supply chains. These standards and others under development take Internet-mediated business dealings beyond procurement/order fulfillment and into the domains of design, manufacturing, and assembly.

For more information on the status of product data exchange standards generated by VFIIP to date, visit the NEMI web site at www.nemi.org and click on "Press Kit: RosettaNet Conference Demo." For more information on the project and NIST's participation, contact Barbara Goldstein, (301) 975-2304; barbara.goldstein @nist.gov. A description of NIST's technical work can be found atwww.eeel.nist.gov/811/manufacture.html. Information on the IPC's proposed 2570 series of supply chain communication standards is available at www.gencam.org/html/standards/productstds2510.html#2570.
Media Contact: Philip Bulman (301) 975-5661; philip.bulman@nist.gov.

HISTORY OF PIONEERING NIST FACILITY CHRONICLED

Automating the Future: A History of the Automated Manufacturing Research Facility 1980-1995 (NIST SP 967), recently published by NIST as part of its centennial celebration, chronicles 15 years of collaboration between government, industry and academia that linked robots, computers and machine tools into what *American Machinist* magazine once called "the free world's largest and most advanced public research facility for the study of automated manufacturing."

The 98-page book recounts the effort that led to one of the first demonstrations of the feasibility of an automated factory. It highlights metrological, technological and management innovations that not only contributed to the success of the AMRF but have now found their place in factories across the nation. These include robotic technologies such as grippers, quick change wrists and image processors; machine tool innovation such as laser interferometer tracking devices, tool wear monitors and special magnet-resistant skin; and standards promoting seamless interfacing between computers.

Readers of *Automating the Future* will understand how the AMRF's achievements illustrate the benefit of multisector sharing of expertise and knowledge; provide insight into how recent manufacturing advances have shaped industry and government; and show the impact of automated manufacturing on the American economy.

A single copy of *Automating the Future: A History of the Automated Manufacturing Research Facility 1980-1995* is available by contacting Barbara Horner, (301) 975-3400; barbara.horner@nist.gov. Multiple copies may be ordered after May 30, 2001, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; (202) 512-1800. Ask for stock No. 003-003-03679-0.
Media Contact: John Blair (301) 975-4261; john.blair @nist.gov.

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Standard Reference Materials

HIGH RESOLUTION WAVELENGTH CALIBRATION SRM FOR WAVELENGTH DIVISION MULTIPLEXING

Wavelength calibration references are needed in the 1500 nm region to support wavelength division multiplexed (WDM) optical fiber communication systems. In a WDM system, many wavelength channels are sent down the same fiber, thereby increasing the bandwidth of the system by the number of channels. If one channel's wavelength were to shift, crosstalk could occur between it and a neighboring channel. NIST scientists have developed a new wavelength reference that is now available as Standard Reference Material (SRM) 2517a. The SRM is an upgrade of SRM 2517; it enables much higher accuracy wavelength calibration of test and measurement equipment.

SRM 2517a, High Resolution Wavelength Calibration Reference for 1510 nm to 1540 nm, can be used to calibrate the wavelength scale and linearity of wavelength measuring equipment. The SRM is a single-mode optical-fiber-coupled absorption cell containing acetylene gas at a pressure of 6.7 kPa (50 Torr). The main difference between SRM 2517a and its predecessor, SRM 2517, is the use of lower pressure in the acetylene cell to produce narrower absorption lines. The lines are about a factor of four narrower than those of SRM 2517. The NIST researchers made accurate measurements of the pressure-shift of the acetylene lines in order to certify the center wavelengths of 56 lines. Fifteen of the lines are certified with an uncertainty of 0.1 pm (about 12 MHz), two lines are certified with an uncertainty of 0.6 pm, and the remainder of the lines are certified with an uncertainty of 0.3 pm. This can be contrasted with the predecessor SRM 2517, whose lines were certified with 0.6 pm uncertainty. Thus SRM 2517a extends the use of this SRM to higher resolution and higher accuracy applications.

CONTACT: Sarah Gilbert, (303) 497-3120; sgilbert@boulder.nist.gov.

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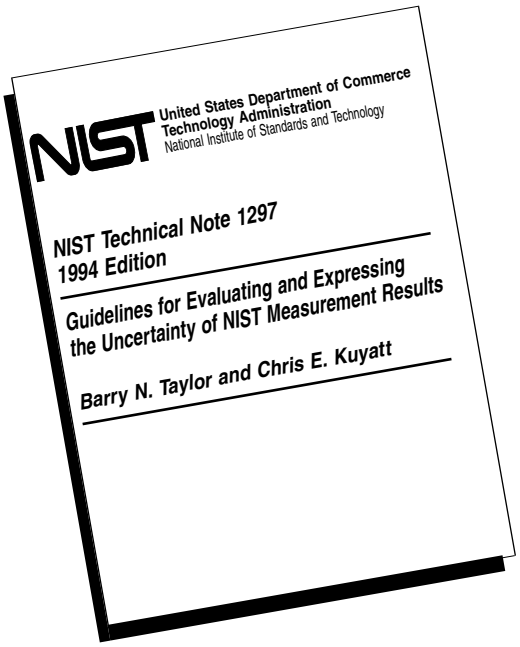


Uncertain about expressing measurement uncertainty? Do you need to know how NIST states the uncertainty of its measurement results and how you can implement their internationally accepted method in your own laboratory? Then you need the newly available 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results.*

The 1994 edition of the National Institute of Standards and Technology Technical Note 1297, *Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results*, by Barry N. Taylor and Chris E. Kuyatt is now available.

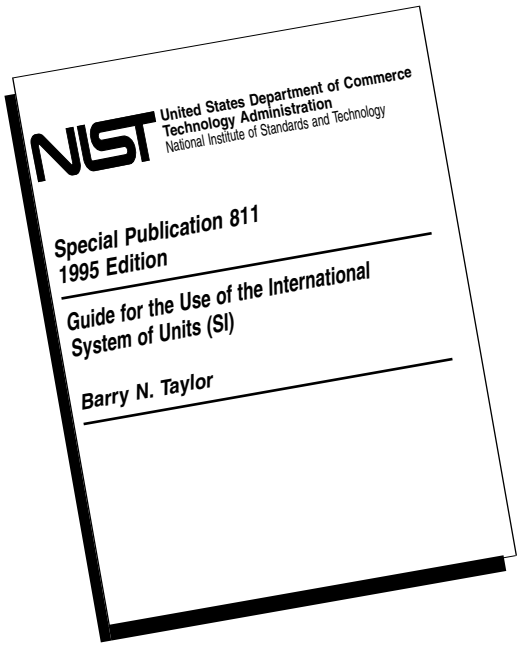
The 1994 edition of TN 1297 includes a new appendix—Appendix D—which clarifies and gives additional guidance on a number of topics related to measurement uncertainty, including the use of certain terms such as accuracy and precision. Very minor word changes have also been made in a few portions of the text of the 1993 edition in order to recognize the official publication in October 1993 by the International Organization for Standardization (ISO) of the *Guide to the Expression of Uncertainty in Measurement* on which TN 1297 is based. However, the NIST policy on measurement uncertainty, Statements of Uncertainty Associated with Measurement Results, which is reproduced as Appendix C of TN 1297, is unchanged.

It is expected that the 1994 edition of TN 1297 will be even more useful than its immediate predecessor, the 1993 edition, of which 10 000 copies were distributed worldwide.

Those United States readers who wish to delve into the subject of measurement uncertainty in greater depth may purchase a copy of the 100-page ISO *Guide* from the Sales Department of the American National Standards Institute (ANSI), 105-111 South State Street, Hackensack, NJ 07601. Copies may also be purchased from the ISO Central Secretariat, 1 rue de Varembé, Case postale 56, CH-1211 Genève 20, Switzerland.

Single copies of the 20-page TN 1297 may be obtained from the NIST Calibration Program, 100 Bureau Dr., Building 820, Room 236, Stop 2330, Gaithersburg, MD 20899-2330, telephone: 301-975-2002, fax: 301-869-3548.

The International System of Units (SI)
The Modern Metric System



Uncertain about the International System of Units (universally abbreviated SI), the modern metric system used throughout the world? Do you need to know the proper way to express the results of measurements and the values of quantities in units of the SI? Do you need to know the NIST policy on the use of the SI? Then you need the 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*.

The 1995 edition of the National Institute of Standards and Technology Special Publication 811, *Guide for the Use of the International System of Units (SI)*, by Barry N. Taylor, is now available.

The 1995 edition of SP 811 corrects a number of misprints in the 1991 edition, incorporates a significant amount of additional material intended to answer frequently asked questions concerning the SI and SI usage, and updates the bibliography. The added material includes a check list for reviewing the consistency of written documents with the SI. Some changes in format have also been made in an attempt to improve the ease of use of SP 811.

The topics covered by SP 811 include:

- NIST policy on the use of the SI in NIST publications.
- Classes of SI units, those SI derived units that have special names and symbols, and the SI prefixes that are used to form decimal multiples and submultiples of SI units.
- Those units outside the SI that may be used with the SI and those that may not.
- Rules and style conventions for printing and using quantity symbols, unit symbols, and prefix symbols, and for spelling unit names.
- Rules and style conventions for expressing the results of measurements and the values of quantities.
- Definitions of the SI base units.
- Conversion factors for converting values of quantities expressed in units that are mainly unacceptable for use with the SI to values expressed mainly in units of the SI.
- Rounding numbers and rounding converted numerical values of quantities.

Single copies of the 84-page SP 811 may be obtained from the NIST Calibration Program, 100 Bureau Dr., Building 820, Room 236, Stop 2330, Gaithersburg, MD 20899-2330, telephone: 301-975-2002, fax: 301-869-3548.

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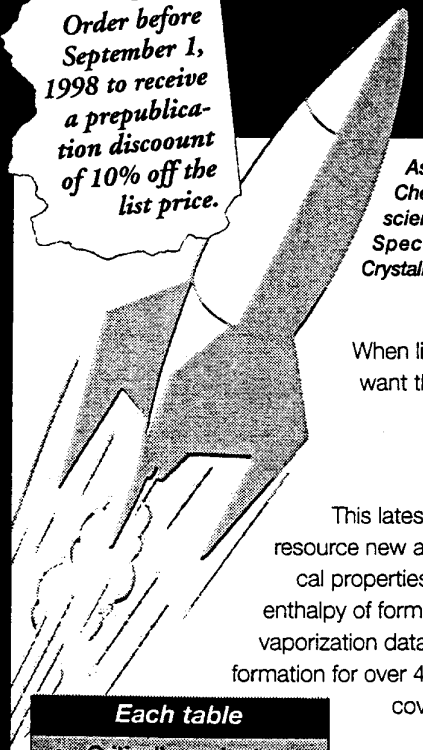

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Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NIST under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NIST administers this program in support of the efforts of private-sector standardizing organizations.

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Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NIST pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NIST Interagency or Internal Reports (NISTIR)—The series includes interim or final reports on work performed by NIST for outside sponsors (both government and nongovernment). In general, initial distribution is handled by the sponsor; public distribution is handled by sales through the National Technical Information Service, Springfield, VA 22161, in hard copy, electronic media, or microfiche form. NISTIR's may also report results of NIST projects of transitory or limited interest, including those that will be published subsequently in more comprehensive form.

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